

P19993.P01

UTILITY PATENT APPLICATION TRANSMITTAL

Only for new nonprovisional applications under 37 CFR 1.53(b)

Attorney Docket No.

P19993

Total Pages

Inventor(s) or Application Identifier
Shoji KARASAWA, Hiromi KAJIYA, Yoshihiro TOKUTOME,
Akihiro TANIGUCHI, Noriyuki FUJIOKA, Masaru MASAKI

Title: ELECTRODE PLATE UNIT FOR RECHARGEABLE
BATTERY AND MANUFACTURING
METHOD THEREOF

ADDRESS TO:

Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

APPLICATION ELEMENTS

ACCOMPANYING APPLICATION PARTS

1. ☒ Fee Transmittal Form
2. ☒ Specification [Total Pages 29]
(preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 USC 113) [Total Sheets 14]
4. ☒ Oath or Declaration [Total Pages 4]
 - a. ☐ Newly executed (original or copy) ☒ Unexecuted
 - b. ☐ Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 18 completed)
[Note Box 5 below]
 - i. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting inventor(s)
named in the prior application, see 37 CFR 1.63(d)(2)
and 1.33(b).
5. ☐ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program (Appendix)
7. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy
 - c. ☐ Statement verifying identity of above copies

8. ☐ Assignment Papers (cover sheet & document(s))
9. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☐ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
14. ☐ Small Entity Statement(s) ☐ Statement filed in prior application, Status still proper and desired
15. ☐ The prior application is assigned of record to _____
16. ☒ Foreign priority claimed
 - a. ☒ Claim of Priority
 - b. ☒ Certified Copy of Priority Document(s)
17. ☒ Other: Cover Letter under 37 C.F.R. 1.53(b) and (f)

18. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior Application No. _____/_____, filed _____
19. ☐ Amend the specification by inserting before the first line the sentence:

This application is a ___ continuation-in-part, ___ continuation, ___ division, of Application No. _____/_____, filed _____.

Address all future correspondence to Customer No. 7055 at the present address of:

GREENBLUM & BERNSTEIN, P.L.C.

 1941 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

Date

Bruce H. Bernstein Reg. No. 33,329
Signature

Bruce H. Bernstein, Reg. No. 29,027
Typed or Printed Name

P19993.P02 <div style="text-align: center; font-weight: bold; font-size: 1.2em;">FEE TRANSMITTAL</div>		<div style="text-align: center; font-weight: bold;">Complete if Known</div> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;">Application Number</td> <td style="width:50%;">Not Yet Assigned</td> </tr> <tr> <td>Filing Date</td> <td>Concurrently Herewith</td> </tr> <tr> <td>First Named Inventor</td> <td>S. KARASAWA et al.</td> </tr> <tr> <td>Group Art Unit</td> <td>Unknown</td> </tr> <tr> <td>Examiner Name</td> <td>Unknown</td> </tr> </table>		Application Number	Not Yet Assigned	Filing Date	Concurrently Herewith	First Named Inventor	S. KARASAWA et al.	Group Art Unit	Unknown	Examiner Name	Unknown																																																																																																																																																																																																																																																																				
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1. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge indicated fees and credit any over payments to: Deposit Account Number <u>19-0089</u> Deposit Account Name <u>GREENBLUM & BERNSTEIN, P.L.C.</u> <input checked="" type="checkbox"/> Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17, including any required extension of time fees in any concurrent or future reply requiring a petition for extension of time for its timely submission (37 CFR 1.136(a)(3)) <input type="checkbox"/> Charge the Issue Fee Set in 37 CFR 1.18 at the Mailing of the Notice of Allowance, 37 CFR 1.311(b) 2. <input checked="" type="checkbox"/> Payment Enclosed: <input checked="" type="checkbox"/> Check <input type="checkbox"/> Money Order <input type="checkbox"/> Other <div style="text-align: center; font-weight: bold;">FEE CALCULATION (fees effective 11/13/99)</div> <div style="font-size: 0.8em;"> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="width:5%;">Large Fee Code</th> <th style="width:10%;">Entity Fee (\$)</th> <th style="width:5%;">Small Fee Code</th> <th style="width:10%;">Entity Fee (\$)</th> <th style="width:40%;">Fee Description</th> <th style="width:10%;">Fee Paid</th> </tr> <tr><td>101</td><td>690</td><td>201</td><td>345</td><td>Utility filing fee</td><td><u>690</u></td></tr> <tr><td>106</td><td>310</td><td>206</td><td>155</td><td>Design filing fee</td><td></td></tr> <tr><td>107</td><td>480</td><td>207</td><td>240</td><td>Plant filing fee</td><td></td></tr> <tr><td>108</td><td>690</td><td>208</td><td>345</td><td>Reissue filing fee</td><td></td></tr> <tr><td>114</td><td>150</td><td>214</td><td>75</td><td>Provisional filing fee</td><td></td></tr> <tr><td colspan="5" style="text-align: right;">SUBTOTAL (1) (\$)</td><td><u>690</u></td></tr> </table> </div> <div style="font-size: 0.8em;"> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="width:5%;">Large Fee Code</th> <th style="width:10%;">Entity Fee (\$)</th> <th style="width:5%;">Small Fee Code</th> <th style="width:10%;">Entity Fee (\$)</th> <th style="width:40%;">Fee Description</th> <th style="width:10%;">Fee Paid</th> </tr> <tr><td>203</td><td>18</td><td>203</td><td>9</td><td>Claims in excess of 20</td><td></td></tr> <tr><td>102</td><td>78</td><td>202</td><td>39</td><td>Independent claims in excess of 3</td><td></td></tr> <tr><td>104</td><td>260</td><td>204</td><td>130</td><td>Multiple dependent claim</td><td></td></tr> <tr><td>109</td><td>78</td><td>209</td><td>39</td><td>Reissue independent claims over original patent</td><td></td></tr> <tr><td>110</td><td>18</td><td>210</td><td>9</td><td>Reissue claims in excess of 20 and over original patent</td><td></td></tr> <tr><td colspan="5" style="text-align: right;">SUBTOTAL (2) (\$)</td><td><u>366</u></td></tr> </table> </div>		Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description	Fee Paid	101	690	201	345	Utility filing fee	<u>690</u>	106	310	206	155	Design filing fee		107	480	207	240	Plant filing fee		108	690	208	345	Reissue filing fee		114	150	214	75	Provisional filing fee		SUBTOTAL (1) (\$)					<u>690</u>	Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description	Fee Paid	203	18	203	9	Claims in excess of 20		102	78	202	39	Independent claims in excess of 3		104	260	204	130	Multiple dependent claim		109	78	209	39	Reissue independent claims over original patent		110	18	210	9	Reissue claims in excess of 20 and over original patent		SUBTOTAL (2) (\$)					<u>366</u>	3. 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*Reduced by Basic Filing Fee paid

SUBMITTED BY		Complete (if applicable)	
Typed or Printed Name	Bruce H. Bernstein	Reg. Number	29,027
Signature	<i>Bruce H. Bernstein</i>	Date	9/18/00
		Deposit Account User ID	

33,329

ELECTRODE PLATE UNIT FOR RECHARGEABLE BATTERY
AND MANUFACTURING METHOD THEREOF

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to an electrode plate unit for a rechargeable battery and a manufacturing method of same.

2. Description of Related Art

10 Batteries are classified into primary batteries and secondary batteries or rechargeable batteries, and there are various configurations for each of these two types of battery. Fig. 17 shows a conventional battery module made by connecting a plurality of rechargeable batteries and coupling them
15 together as one so as to obtain the necessary power. In this battery module, a plurality of cells 41 (41a to 41j) made of sealed alkaline rechargeable batteries as shown in Fig. 18 are arranged side by side, with the long lateral walls of their battery cases 42 adjacent each other. End plates 52 are
20 arranged against the outside of the cells 41a and 41j at both ends, and the group of batteries and the two end plates 52 are bound together with binding bands 53 so as to couple the cells together as one piece.

For the cells 41, an electrode plate group 47, comprising
25 positive electrode plates and negative electrode plates layered

with intervening separators, thereby constituting elements for electromotive force, is accommodated in a battery case 42 together with a liquid electrolyte, and the open end of the battery case 42 is closed with a lid 46 provided with a safety vent 45. From the upper end at one side of the positive electrode plates forming the electrode plate group 47, leads 49 extend upward and are connected to a positive electrode terminal 43 above them, and similarly, from the upper end of the other side of the negative electrode plates, leads 49 extend upward and are connected to an negative electrode terminal 44 above them. The positive electrode terminal 43 and the negative electrode terminal 44 are attached to the lid 46.

The positive electrode terminals 43 and negative electrode terminals 44 of coupled neighboring cells 41 are connected by connection plates 51, thereby connecting all cells 41 in series. When the battery cases 42 are coupled, ribs 48, which protrude vertically from the long lateral walls of the battery cases 42, are abutted against each other, forming coolant passages running in the vertical direction along the long lateral walls of the battery cases 42 in the space between ribs 48. The cells 41a to 41j are cooled by flowing air through these coolant passages.

The leads 49 are integrated to the electrode plate group 47 by welding. For the welding of the leads, according to Japanese Laid-Open Patent Application 7-220715, for example,

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laser welding is used more favorably than resistance welding, because, in resistance welding, the welding defects are often formed by the generation of sparks caused by oxide films or other foreign substances that exist in the welding portion, and uniform welding cannot always be accomplished. Thus laser welding is more favorably applied, and specifically, leads are usually provided with through-holes, through which laser beams are passed, whereby these through-holes are closed with molten metal, and when the metal eventually cools down and sets, the leads are integrally welded together.

With the configuration for the cells 41 of this conventional battery module, leads 49 extend from a portion at the upper end on one side of the electrodes and are connected to the electrode terminals 43 and 44, and consequently, there were the problems that the internal resistance of the battery was large, because the average distance from the surface of the electrodes to the collector portions of the leads 49 was long, and that the power output was low, because the utilization rate of the electrode active material was low.

The inventors of the present application have proposed an electrode plate unit for a rechargeable battery, wherein collector plates are abutted on the entire surface of the opposite lateral ends of the group of electrode plates, with lateral edges of each of electrode plates being integrally welded to the collector plates. In connecting the lateral

edges of the electrode plates to the collector plates, however, sufficient bond cannot be achieved in the case of employing a seam-welding method, with the result that power output of the battery is decreased, or the welding strength is low. On the other hand, if laser welding is used, it is difficult to accomplish secure bonding of electrode plates with the collector plates without causing any adverse effects to the electrode plates. Accordingly, there is the need for a method of bonding lateral edges of electrode plates with collector plates in a favorable condition.

SUMMARY OF THE INVENTION

In view of these problems of the prior art, it is an object of the present invention to provide an electrode plate unit for a rechargeable battery, in which one lateral edge of an electrode plate group is securely bonded to a collector plate, and to a manufacturing method thereof.

To achieve the above object, a battery according to one aspect of the present invention comprises an electrode plate unit, including:

a plurality of positive electrode plates and a plurality of negative electrode plates that are alternately stacked upon one another with intervening separators therebetween, thereby constituting a group of electrode plate, wherein lateral edges of the positive electrode plates protrude beyond the negative

electrode plates on one side, and lateral edges of the negative electrode plates protrude beyond the group of positive electrode plates on the opposite side; and

5 a positive electrode collector plate and a negative electrode collector plate that are respectively bonded to said protruded lateral edges of the positive electrode plates and the negative electrode plates, wherein the positive electrode collector plate and the negative electrode collector plate are formed with protruded portions on a surface which is to be
10 bonded to the lateral edges of the positive electrode plates and the negative electrode plates.

While novel features of the invention are set forth in the preceding, the invention, both as to organization and content, can be further understood and appreciated, along with other
15 objects and features thereof, from the following detailed description and examples when taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Fig. 1 is an external perspective view of a battery module according to one embodiment of the present invention;

Fig. 2 is a partial lateral cross-sectional view of the same;

Fig. 3 is a cross-sectional view taken in the direction of
25 the arrows along the line III - III in Fig. 2;

Fig. 4 is a front view of an electrode plate unit of the same embodiment;

Fig. 5 is a cross-sectional view taken in the direction of the arrows along the line V - V in Fig. 4;

5 Fig. 6A is a front view, Fig. 6B is a top plan view, and Fig. 6C is an enlargement of VIC in Fig. 6B, showing a positive electrode plate in the same embodiment;

Fig. 7A is a front view, Fig. 7B is a top plan view, and Fig. 7C is an enlargement of VIC in Fig. 7B, showing a negative
10 electrode plate in the same embodiment;

Fig. 8 is a flow chart of a manufacturing method of the electrode plate unit;

Fig. 9A is a partial front view and Fig. 9B is a partial side view showing one process step of manufacturing the
15 electrode plate unit;

Fig. 10 is a perspective view showing one process step of welding a collector plate to the electrode plate group;

Fig. 11A is a partial front view and Fig. 11B is a partial side view showing the welding step of Fig. 10;

20 Fig. 12A is a front view, Fig. 12B is a longitudinal side elevation view, Fig. 12C is an enlargement of XIIC in Fig. 12B, and Fig. 12D is an enlargement of XIID in Fig. 12B, showing a collector plate in the same embodiment;

Fig. 13A is a front view, Fig. 13B is a longitudinal side
25 elevation view, Fig. 13C is an enlargement of XIIIC in Fig.

13B, and Fig. 13D is an enlargement of XIIIID in Fig. 13B,
showing a modification of the collector plate;

Figs 14A-14E are diagrams given in explanation of various
modifications of the arrangement of a corrugated portion of the
5 collector plate and a nickel solder material attached thereto;

Fig. 15A is a front view showing one modified example of a
lead portion of the electrode plate, Figs. 15B and 15C are
diagrams given in explanation of another modified example; and
Fig. 15D is a partial front view showing yet another modified
10 example;

Figs. 16A and 16B are diagrams given in explanation of
another modified examples of the lead portion of the electrode
plate;

Fig. 17 is an external perspective view of a conventional
15 battery module; and

Fig. 18 is a partially cutaway perspective view of a cell
of the same conventional example.

DESCRIPTION OF PREFERRED EMBODIMENTS

20 One embodiment of a battery module, to which an electrode
plate unit for a battery according to the present invention is
applied, will be hereinafter described with reference to Figs.
1 to 12.

First, the overall construction of the battery module 1 in
25 accordance with this embodiment is described with reference to

protrusions 14. A plurality of protrusions 16 and indentations 17, for positioning and fitting together integral battery cases 2 when their side walls 12 are abutted on each other, are arranged at an upper portion and a lower portion of the outer surface of the two ribs 13 near both ends of the side wall 12 of the integral battery case 2. When a plurality of integral battery cases 2 are arranged in a row in parallel to constitute a battery module, the ribs 13, the protrusions 14 and the coupling ribs 15a and 15b form coolant passages for cooling the cell cases 3 effectively and uniformly.

The aforementioned electrode plate groups 5 are explained in detail with reference to Figs. 4 to 7. In Figs. 4 and 5, a plurality of positive electrode plates 18 and negative electrode plates 19 are arranged alternately, and the positive electrode plates 18 are covered with separators 20 in the form of a bag having an opening on one side. The positive electrode plates 18 and the negative electrode plates 19 are stacked upon one another with separators 20 therebetween, thereby constituting the electrode plate unit 5. In Fig. 4, the region where the positive electrode plates 18 and the negative electrode plates 19 oppose each other with the intervening separators 20 and generate electric power is indicated by oblique lines. The lateral edges of the group of positive electrode plates 18 protrude beyond the group of negative electrode plates 19 on one side, and the lateral edges of the

group of negative electrode plates 19 protrude beyond the group of positive electrode plates 18 on the opposite side, and these protruding lateral portions form the lead portions 18a and 19a, to the lateral ends of which collector plates 21 and 22 are welded, respectively. The outer edges of the collector plates 21 and 22 are bent toward the inside as shown in Fig. 5, in order to restrict the dimensions of the electrode plates 18, 19 during the collector plates 21, 22 are welded to the electrode plates 18, 19, so that the electrode plates 18, 19 do not spread outwards as pressure is applied thereto. Numeral 23 denotes external separators arranged at the outer faces of the electrode plate unit 5 between the collector plates 21 and 22.

The positive electrode plates 18 are made of Ni foamed metal. As shown in Figs. 6A-6C, the lead portion 18a is constructed by compressing one lateral edge of the plate of foamed metal and attaching a lead plate 24 on one surface of the lead portion 18a by ultrasonic welding or seam welding. The negative electrode plates 19 shown in Figs. 7A-7C are made of Ni punched metal coated with an active material except for lead portions 19a. "L" denotes the length of a side of the positive electrode plate 18 and the negative electrode plate 19 where the lead portions 18a and 19a are provided, and "D" denotes the length of the side in a direction perpendicular thereto. The positive and negative electrode plates 18, 19 are configured so that "L" is larger than "D", but not larger than

four times "D". In Figs. 4, 6A-6C, and 7A-7C, numeral 25 denotes pairs of locating holes formed in the lead portions 18a and 19a at a suitable distance from the top and the bottom thereof.

5 The detailed construction of the electrode plate unit 5 and the manufacturing method thereof will be described below with reference to Figs. 8 to 12. Fig. 8 is a flow chart of the manufacturing steps. First, the positive electrode plates 18 and the negative electrode plates 19 fabricated as shown in
10 Figs. 6A and 7A respectively are completely dried, and then a predetermined number of positive and negative electrode plates 18, 19 are alternately stacked upon one another, with a separator 20 interposed between each pair of positive and negative electrode plates, whereby a group of electrode plates
15 as shown in Fig. 5 is obtained but without collector plates 21, 22. These stacked electrode plates 18, 19 are then set in a suitable mold equipped with locating pins 26, such that the locating pins 26 are passed through corresponding locating holes 25 in the positive and negative electrode plates 18, 19.
20 Then, the lateral edges of the electrode plates 18, 19 are pressed with a press 27 as shown in Figs. 9A and 9B, so that the lateral edges of the electrode plates together form a flat end surface. Thereafter, the thus formed lateral end surface is inspected if it is flat. In case there is an electrode
25 plate which is not flush with the flat end surface, such is

removed as a defective one and replaced. Such inspection of end surface can be performed efficiently by way of laser focusing method or the like, so that the variation of electrode plates in their dimensions is less than $100\mu\text{m}$.

- 5 Next, collector plates 21, 22 are attached on each of the end surfaces of the electrode plate groups formed by the lateral edges of the groups of positive and negative electrode plates 18, 19 respectively, and the collector plates 21, 22 are demagnetized by applying an alternating magnetic field thereto.
- 10 Then, an electronic beam 28 is irradiated to the backside, or the opposite side of the electrode plate group, of the collector plates 21, 22 within a vacuum, in a state wherein the collector plates 21, 22 are pressed against the electrode plates. The electronic beam 28 is scanned in directions in
- 15 which the electrode plates are stacked as indicated by the arrow in Fig. 10, whereby the collector plates 21, 22 are welded to the lateral edges of the positive and negative electrode plates 18, 19, respectively. This welding operation is repeated in several locations at certain intervals along the
- 20 lengthwise direction of the electrode plates 18, 19 simultaneously or successively. While the collector plates 21, 22 may be magnetized during the fabrication or transportation process thereof, since they are demagnetized beforehand as noted above, there is no risk that the electronic beam 28 is

adversely affected by any magnetic force and welding performance fails.

Various other lasers such as CO₂ laser, YAG laser, semiconductor laser, or excimer laser can be used instead of
5 electronic beam 28.

The collector plates 21, 22 are constructed of a nickel sheet or nickel-plated steel sheet, and formed with corrugated portions 29 at a plurality of positions (seven positions in the drawing) at suitable intervals in a lengthwise direction of the
10 sheet, as shown in Figs. 12A through 12D. The corrugated portion 29 partly protrudes toward the side of the electrode plates 18, 19, and a solder material 30 such as nickel solder is attached to a portion that makes contact with the lateral edges of the positive and negative electrode plates 18, 19.
15 Fig. 12D shows in detail one example of the corrugated portion 29, wherein a groove 29b is formed on the top of the ridge 29a of the corrugated portion 29, this groove 29b being filled with the nickel solder material 30. Reference numeral 31 denotes part of the collector plate 21 or 22 on one end thereof which
20 makes a welding portion to be welded with a connection fitting 9.

When attaching the nickel solder 30 on the collector plates 21, 22, the collector plates need to be thoroughly cleaned to remove oil components therefrom. The nickel solder
25 may be obtained by mixing powder consisting of nickel metal

alloy with binder into a paste. This is applied on the collector plates 21, 22 at desired locations in a predetermined amount, and the collector plates 21, 22 are then heated in a vacuum furnace at 450 to 800°C for 10 to 30 minutes, whereby
5 the nickel solder paste is reflowed. The collector plates 21, 22 should preferably be pressed afterwards to correct warping of the plates and to flatten out the reflowed portions.

According to the construction of the electrode plate unit and the manufacturing method thereof described above, lateral
10 edges of the electrode plates 18, 19 can be brought in secure contact with collector plates 21, 22 and bonded reliably thereto, since the electrode plates 18, 19 have their respective lead portions 18a, 19a along one lateral edge, which is to be welded with a collector plate, where no active
15 material is packed, and since these lead portions 18a, 19a include locating holes 25 for positioning the electrode plates with respect to the collector plate. Further, since the lead portion 18a of the positive electrode plate 18 that is made of metal foam and thus is low in strength is reinforced with the
20 lead plate 24, sufficient strength for the lead portion 18a can be achieved, and the lead portion 18a is prevented from being irregularly deformed during welding, ensuring secure bond to the collector plate.

Furthermore, lateral edges of the positive and negative
25 end plates 18, 19 are aligned straight by pressing the edges of

the electrode plates, that have been located in position by means of the locating pins 26 and the corresponding holes 25, before placing the collector plates 21, 22 on the end surfaces of the electrode plate groups. Heat is applied to the collector plates 21, 22 as they are pressed against the edges of the electrode plates 18, 19, the collector plates 21, 22 remain in secure contact with the electrode plates during the welding, thus achieving secure bond therewith.

For the welding, with a single or a plurality of electronic beam 28 or using any other non-contact type heat source, heat is applied to the collector plates 21, 22 on the opposite surface of the electrode plate group along a line in the direction in which the electrode plates are stacked. Therefore, welding can be performed at high speed without affecting other parts of the electrode plate group that is in tight contact with the collector plates. Since the electrode plates 18, 19 are welded together along a plurality of lines in the plate-stacking direction, they can be securely bonded to the collector plates 21, 22.

The plurality of corrugated portions 29 that extend in the plate-stacking direction are formed at suitable intervals, whereby, the edges of the group of positive electrode plates 18 and the edges of the negative electrode plates 19 are reliably bonded to the collector plates 21, 22 respectively at several locations. Thus an electrode plate unit 5, wherein the

collector plates 21, 22 and the electrode plates 18, 19 are securely bonded together, can be obtained.

The solder material 30 is attached to the corrugated portions 29 of the collector plates 21, 22 that are in contact with the lateral edges of the electrode plates 18, 19. Since the solder material melts at a relatively low temperature, the collector plates 21, 22 can be bonded to the edges of the electrode plates 18, 19 without arising any problems caused by thermal effect to the electrode plates 18, 19. Further, since both of the collector plates 21, 22 and the electrode plates 18, 19 are mainly composed of nickel, they can be favorably bonded together to constitute an electrode plate unit 5 for a nickel-alkaline rechargeable battery.

The electronic beams 28 for heat application are irradiated within a vacuum, so that the metal will not oxidize by the heat during the welding. Due to the absence of any oxide films, no welding defects are formed and bonding can be accomplished favorably, and the battery performance will not deteriorate. Moreover, since the collector plates 21, 22 are demagnetized as being coupled to the electrode plates 18, 19 before applying heat with the electronic beams 28, any magnetic force that the collector plates 21, 22 may have acquired during the fabrication or transportation process can be removed, whereby electronic beams 28 will not be affected by a magnetic force, and bonding can be accomplished favorably.

Next, modifications of the corrugated portion 29 in the collector plates 21, 22 will be described. Instead of forming several corrugated portions 29 as shown in Figs. 12A-12D, wherein a groove 29b is formed on the top of the ridge 29a on the backside, the corrugated portion may simply be formed as an groove as shown in Figs. 13A-13D, the backside of which protrudes as a ridge 29a on the side facing the lateral end surface of the electrode plates 18, 19. The solder material 30 is attached on the ridge 29a. Reference numeral 32 in Figs. 13A-13C represents a connection projection that is formed to protrude at one end of the collector plate 21 or 22. The connection projection 32 is inserted into the connection hole 7 formed in the short lateral walls of the cell cases 3, so that the leading ends 32a of two connection projections 32 of the collector plates in two neighboring cells 3 are abutted, these being welded together. Thus, according to this structure, the collector plates 21, 22 of adjacent cells 6 can be directly connected without using a connection fitting 9.

The shape of the corrugated portion 29 and the arrangement of the solder material 30 can variously be modified as shown in Figs. 14A-14E. Fig. 14A shows one example that is basically the same as that shown in Fig. 12D, but with the surface of the solder material 30 filled in the groove 29b protruding slightly more than the ridge 29a. Fig. 14B shows another example wherein the ridge 29a is formed to protrude rather sharply,

with a narrower and shallower groove 29b being formed on the top thereof, so that the solder material 30 can be projected more prominently. Fig. 14C shows yet another example which is basically the same as that shown in Fig. 13D, but with the

5 ridge 29a being protruded higher and more sharply, and the solder material 30 being attached on the top of the ridge 29a and over the both sides thereof. Fig. 14D shows yet another example wherein the solder material 30 is applied in a strip on the surface of the collector plate 21 or 22, so that the solder

10 material 30 itself constitutes a ridge 29b. Fig. 14E shows yet another example, wherein the solder material 30 is applied over the surface of the collector plates 21, 22 by non-electrolytic plating. The thickness of the solder material 30 may suitably be set within the range of 20 to 200 μ m.

15 Figs. 15A-15D show various modifications to the electrode plates 18, 19. While the lead portions 18a, 19a of the electrode plates 18, 19 have been described as being straight at lateral edges in the foregoing embodiments, Fig. 15A shows one example of modification, wherein the edge of the lead

20 portion 18a or 19a of the electrode plate 18 or 19 is formed with cuts or indents 34, so that the portions to be welded to the collector plate 21 or 22 can be bent more easily. Alternatively, the lateral edges of the lead portions 18a, 19a of the positive and negative electrode plates 18, 19 can be

25 provided with bent portion 33 as shown in Fig. 15B. By doing

so, even when, because of the dimensional tolerances for example, there is a difference d in the position of the lateral edges of the electrode plates 18, 19 that are aligned straight by the locating pins 26, the edge position of the electrode plates 18, 19 can be aligned more easily along a straight line as shown in Fig. 15C when a collector plate 21 or 22 is pressed against the electrode plates, because of the bent portion 33 smoothly bending and adjusting, so that the edges of the electrode plates 18, 19 together form a uniform, flat end surface, which will be in favorable contact with the collector plates 21, 22. More preferably, the examples shown in Fig. 15A and Figs. 15B, 15C can be applied in combination, such that bent portions 33 are formed by making cuts or slits 35 on both sides of the bent portions 33 as shown in Fig. 15D, at locations corresponding to the corrugated portions 29 of the collector plates 21, 22.

The shape of the bent portion 33 should not be limited to the example shown in Figs. 15B and 15C, wherein the edge of the electrode plate is bent at an angle, but can be variously arranged, such as to be bent round at more than 90° as shown in Fig. 16A, or bent round at nearly 180° as shown in Fig. 16B.

In the foregoing embodiment, a method of attaching the solder material 30 on the corrugated portions 29 of the collector plates 21, 22, wherein a row material of solder paste is applied and reflowed, has been described as one example.

However, the solder material 30 can be attached by any other means, for example, using an adhesive, or by thermal welding.

Alternatively, a material that is similar to the nickel solder material 30, such as a metal alloy comprising nickel, can be applied over the entire surface of the collector plates 21, 22 by a non-electrolytic plating method or the like. In the case wherein the collector plates 21, 22 are made of a nickel-plated steel sheet, a material that is similar to that of the nickel solder paste 30 may suitably selected for the plating of the steel sheet. In this case, a ridge of solder material 30 can be formed by locally increasing the thickness of the nickel plate.

Although the present invention has been fully described in connection with the preferred embodiment thereof, it is to be noted that various changes and modifications apparent to those skilled in the art are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

The present disclosure relates to subject matter contained in priority Japanese Patent Application No. HEI 11-267001, filed on September 21, 1999, the contents of which is herein expressly incorporated by reference in its entirety.

CLAIMS

WHAT IS CLAIMED IS:

1. A battery comprising an electrode plate unit,
including:

5 a plurality of positive electrode plates and a plurality
of negative electrode plates that are alternately stacked upon
one another with intervening separators therebetween, thereby
constituting a group of electrode plate, wherein lateral edges
of the positive electrode plates protrude beyond the negative
10 electrode plates on one side, and lateral edges of the negative
electrode plates protrude beyond the group of positive
electrode plates on the opposite side; and

a positive electrode collector plate and a negative
electrode collector plate that are respectively bonded to said
15 protruded lateral edges of the positive electrode plates and
the negative electrode plates, wherein the positive electrode
collector plate and the negative electrode collector plate are
formed with protruded portions on a surface which is to be
bonded to the lateral edges of the positive electrode plates
20 and the negative electrode plates.

2. The battery according to Claim 1, wherein a plurality
of elongated protrusions that extend along a direction in which
the electrode plates are stacked are formed at predetermined
intervals on the positive and negative collector plates.

3. The battery according to Claim 1, wherein the collector plates are made of either one of nickel sheet or nickel-plated steel sheet.

4. The battery according to Claim 1, wherein a solder material is attached at portions in the positive and negative collector plates that are to be bonded to the lateral edges of the electrode plate group.

5. The battery according to Claim 4, wherein the solder material is applied on the positive and negative collector plates beforehand and is reflowed afterwards.

6. A battery comprising an electrode plate unit, including:

a plurality of positive electrode plates and a plurality of negative electrode plates that are alternately stacked upon one another with intervening separators therebetween; and

a collector plate welded to lateral edges of at least one of the positive electrode plates and the negative electrode plates, wherein the lateral edges of the positive electrode plates or the negative electrode plates are formed with bent portions.

7. A battery comprising an electrode plate unit, including:

a plurality of positive electrode plates and a plurality of negative electrode plates that are alternately stacked upon one another with intervening separators therebetween, thereby

constituting a group of electrode plate, wherein lateral edges of the positive electrode plates protrude beyond the negative electrode plates on one side, and lateral edges of the negative electrode plates protrude beyond the group of positive

5 electrode plates on the opposite side, said lateral edges of the positive electrode plates and the negative electrode plates being formed with slits; and

a positive electrode collector plate and a negative electrode collector plate that are respectively bonded to said
10 protruded lateral edges of the positive electrode plates and the negative electrode plates.

8. A battery comprising an electrode plate unit, including:

a plurality of positive electrode plates and a plurality
15 of negative electrode plates that are alternately stacked upon one another with intervening separators therebetween, said positive electrode plates and negative electrode plates having their respective lead portions along one lateral edge thereof; and

20 a collector plate welded to the lead portions of at least one of the positive electrode plates and the negative electrode plates, wherein said lead portions include locating means for positioning the lateral edges of the positive or negative electrode plates with respect to the collector plate.

9. The battery according to Claim 8, wherein the locating means is a hole or a cut-out.

10. The battery according to Claim 9, wherein the locating means comprises one circular hole and one oblong hole.

5 11. The battery according to Claim 8, wherein the lead portions of the positive electrode plates are provided with a reinforcing material.

12. A method of manufacturing an electrode plate unit for a battery comprising the steps of:

10 stacking a plurality of positive electrode plates and a plurality of negative electrode plates alternately upon one another with intervening separators therebetween;

bringing a collector plate in tight contact with lateral edges on one lateral side of the positive or negative electrode
15 plates; and

applying heat to the collector plate on an opposite surface of the electrode plates from a non-contact type heat source at several locations in lines along a direction in which the electrode plates are stacked.

20 13. The method of manufacturing an electrode plate unit for a battery according to Claim 12, wherein a solder material is attached on the collector plate on a surface which is contacted with the electrode plates along a plurality of lines in the direction in which the electrode plates are stacked, and
25 heat is applied upon said solder material.

14. The method of manufacturing an electrode plate unit for a battery according to Claim 12, wherein the positive or negative electrode plates are pressed against a locating means so that the lateral edges on one lateral side of the positive or negative electrode plates are aligned, and heat is applied to the collector plate in a state wherein the collector plate is tightly pressed against the lateral edges of the positive or negative electrode plates.

15. The method of manufacturing an electrode plate unit for a battery according to Claim 12, wherein heat is applied to the collector plate by irradiating an electronic beam within a vacuum.

16. The method of manufacturing an electrode plate unit for a battery according to Claim 15, wherein the collector plate, together with the electrode plates in contact therewith, is demagnetized before the application of heat.

17. A method of manufacturing an electrode plate unit for a battery comprising the steps of:

stacking a plurality of positive electrode plates and a plurality of negative electrode plates alternately upon one another with intervening separators therebetween, such that lateral edges of the positive electrode plates protrude beyond the negative electrode plates on one side, and lateral edges of the negative electrode plates protrude beyond the group of positive electrode plates on the opposite side; and

welding a collector plate to the lateral edges of at least one of the positive electrode plates and the negative electrode plates, wherein a solder material is arranged in advance to the collector plate at locations to be bonded to the lateral edges
5 of the positive or negative electrode plates.

18. The method of manufacturing an electrode plate unit for a battery according to Claim 17, wherein the solder material is applied on the collector plate by electrolytic or non-electrolytic plating.

10 19. The method of manufacturing an electrode plate unit for a battery according to Claim 17, wherein the solder material is attached on the collector plate by welding a sheet-like solder material to the collector plate.

20 20. The method of manufacturing an electrode plate unit
15 for a battery according to Claim 17, wherein the solder material is attached on the collector plate on a surface which is contacted with the electrode plates along a plurality of lines in the direction in which the electrode plates are stacked, and heat is applied upon said solder material.

20 21. A method of manufacturing an electrode plate unit for a battery comprising the steps of:

stacking a plurality of positive electrode plates and a plurality of negative electrode plates alternately upon one another with intervening separators therebetween, such that
25 lateral edges of the positive electrode plates protrude beyond

the negative electrode plates on one side, and lateral edges of the negative electrode plates protrude beyond the group of positive electrode plates on the opposite side;

pressing the positive or negative electrode plates against
5 a locating means so that the lateral edges on one lateral side of the positive or negative electrode plates are aligned;

bringing a collector plate in tight contact with said aligned lateral edges on one lateral side of the positive or negative electrode plates; and

10 applying heat to the collector plate on an opposite surface of the electrode plates from a non-contact type heat source at several locations in lines along a direction in which the electrode plates are stacked.

22. The method of manufacturing an electrode plate unit
15 for a battery according to Claim 21, wherein heat is applied to the collector plate by irradiating an electronic beam within a vacuum.

23. The method of manufacturing an electrode plate unit for a battery according to Claim 22, wherein the collector
20 plate, together with the electrode plates in contact therewith, is demagnetized before the application of heat.

ABSTRACT OF THE DISCLOSURE

A plurality of positive electrode plates and negative electrode plates are stacked alternately upon one another with
5 intervening separators therebetween, wherein lateral edges of the positive electrode plates protrude beyond the negative electrode plates on one side, and lateral edges of the negative electrode plates protrude beyond the group of positive electrode plates on the opposite side. Collector plates are
10 brought in tight contact with respective lateral edges of the positive and negative electrode plates, and heat is applied to the collector plate on an opposite surface of the electrode plates from a non-contact type heat source at several locations in lines along a direction in which the electrode plates are
15 stacked.

Fig. 1

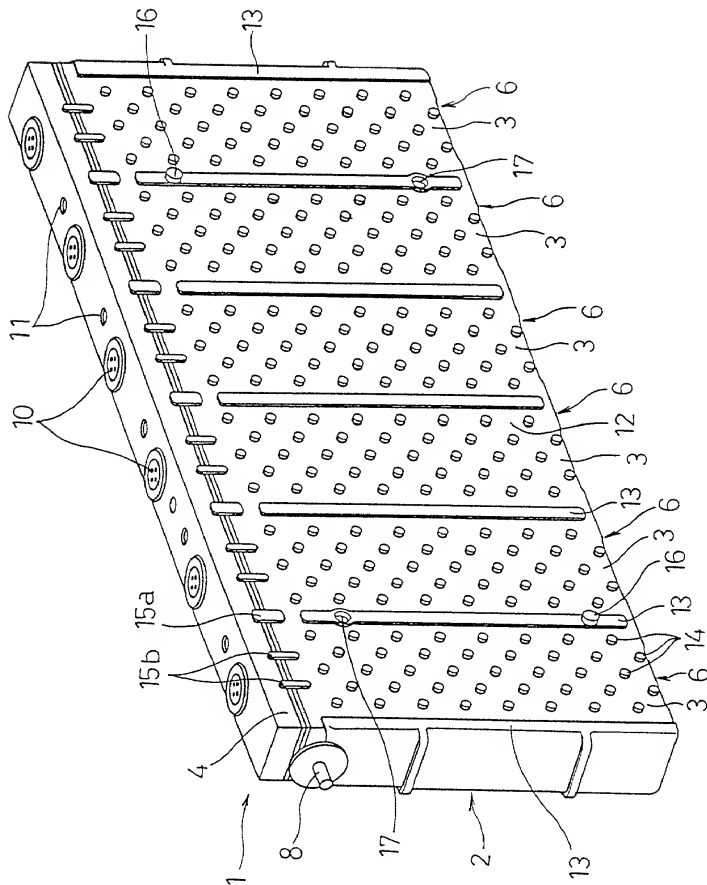


Fig. 2

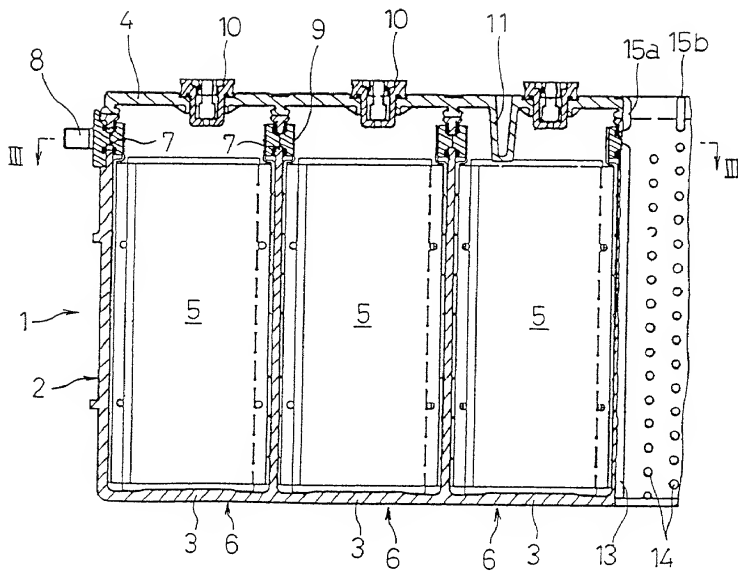


Fig. 3

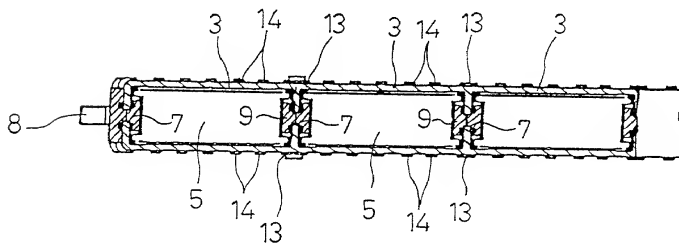


Fig. 4

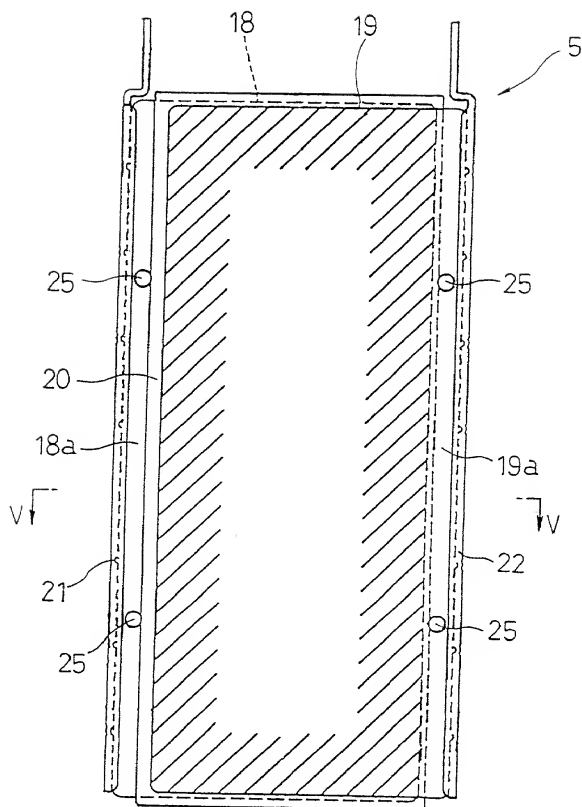


Fig. 5

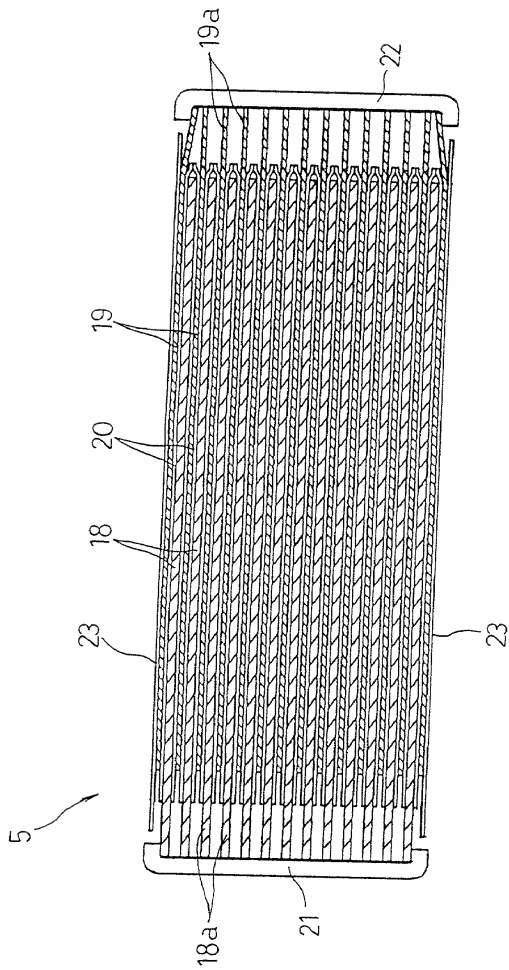


Fig. 6 C

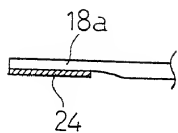


Fig. 6 B

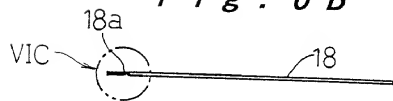


Fig. 6 A

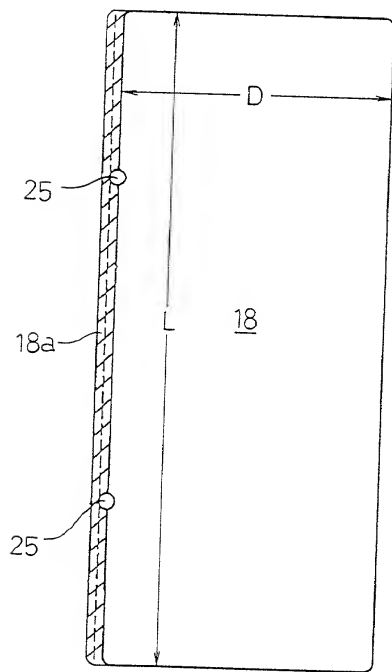


Fig. 7B

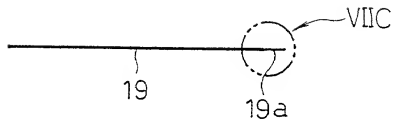


Fig. 7A

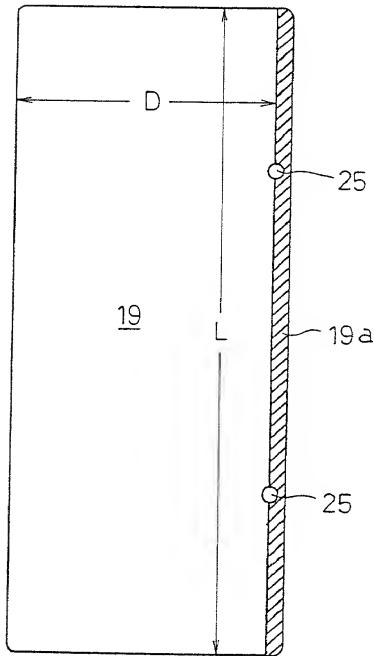


Fig. 7C

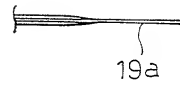


Fig. 8

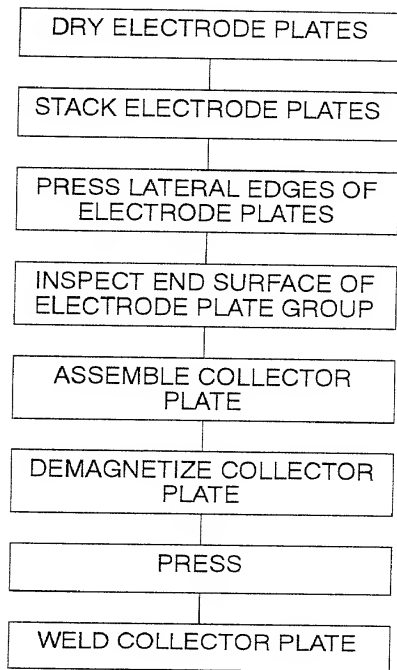


Fig. 9 A

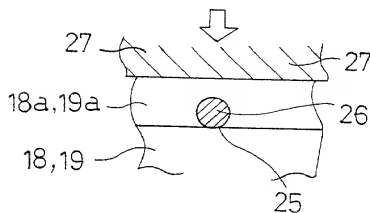


Fig. 9 B

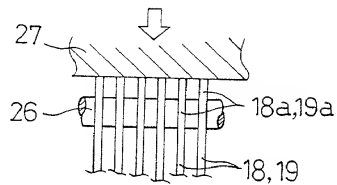


Fig. 10

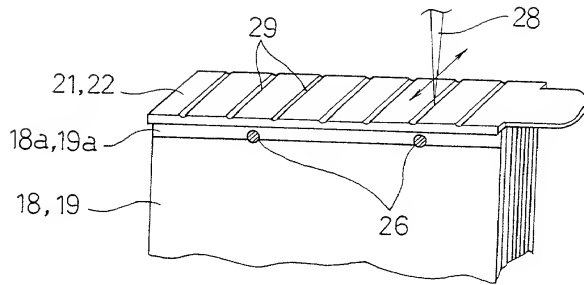


Fig. 11 A

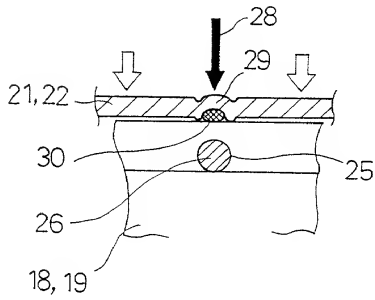
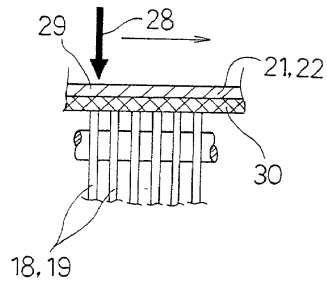


Fig. 11 B



09561337 091000

Fig. 13A Fig. 13B

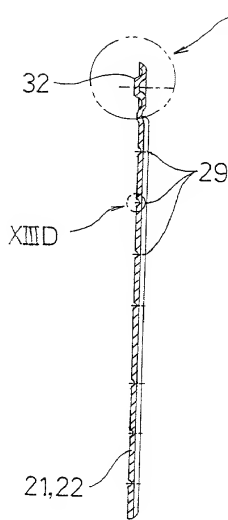
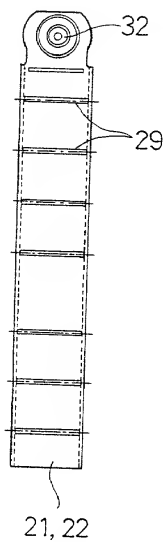


Fig. 13C

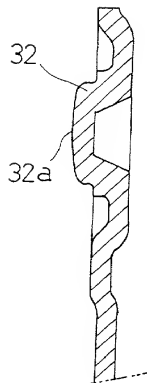


Fig. 13D

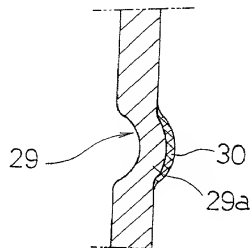


Fig. 14 A

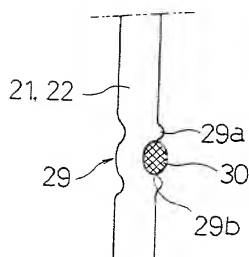


Fig. 14 B

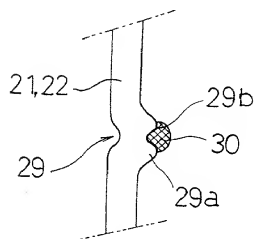


Fig. 14 C

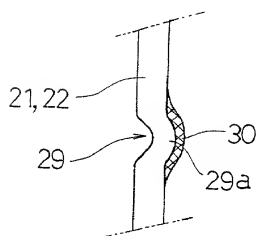


Fig. 14 D

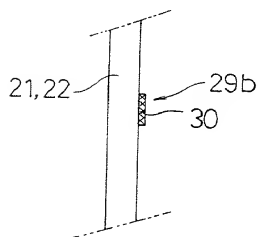
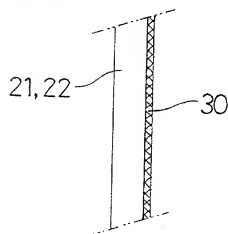


Fig. 14 E



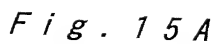


Fig. 16 A

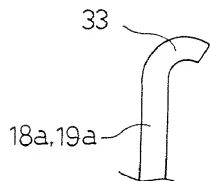


Fig. 16 B

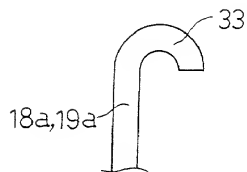


Fig. 17
Prior Art

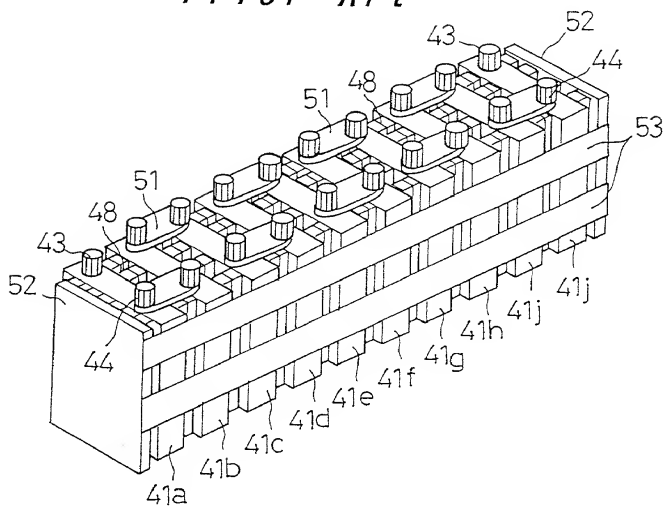
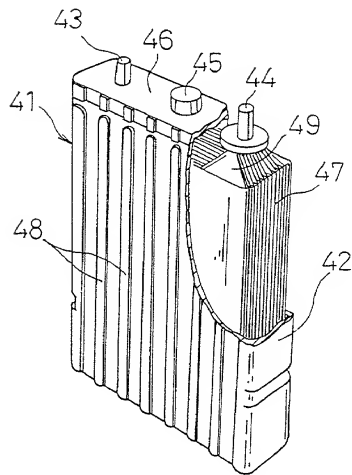


Fig. 18
Prior Art



Declaration and Power of Attorney For Utility or Design Patent Application

特許出願宣言書

Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり

宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である(一人の氏名のみが下欄に記載されている場合)か、もしくは本来の、最初にして共同の発明者である(複数の氏名が下欄に記載されている場合)と信じ、

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ELECTRODE PLATE UNIT FOR RECHARGEABLE BATTERY

AND MANUFACTURING METHOD THEREOF

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as

United States Application Number _____

and was amended on _____ (if applicable) or,

PCT International Application Number _____

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority under Title 35, United States Code §119(a-d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below. I have also identified below, by checking the "No" box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed:

Prior foreign applications

先の外国出願

P11-267001

(Number)
(番号)

JAPAN

(Country)
(国名)

21/SEPTEMBER/1999

(Day/Month/Year Filed)
(出願の年月日)

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

Priority claimed

優先権の主張

☒ Yes
あり
☐ No
なし
☐ Yes
あり
☐ No
なし

☐ その他の外国特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto.

Japanese Language Utility or Design Patent Application Declaration

私は、合衆国法典第35部第119条(e)項に基づく、下記の合衆国仮特許出願の利益を主張する。

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

☐ その他の合衆国仮特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

私は、合衆国法典第35部第120条に基づく下記の合衆国特許出願、又は第365条(c)項に基づく合衆国を指名したPCT国際出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112条第1項規定の態様で、先の合衆国特許出願又はPCT国際出願に開示されていない限度において、先の出願の出願日と本願の国内出願日又はPCT国際出願日の間に有効となった連邦規則法典第37部第1章第56条に記載の特許要件に所要の情報を開示すべき義務を有することを認める。

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

☐ その他の合衆国又は国際特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional U.S. or international application numbers are listed on a supplemental priority sheet attached hereto.

私は、ここに自己の知識にもとずいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽による陳述が本願ないし本願に対して付与される特許の有効性を損なうことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Japanese Language Utility or Design Patent Application Declaration

委任状： 私は、下記発明者として、下記に明記された顧客番号を伴う以下の弁護士又は、代理人をここに選任し、本願の手続きを遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する。そして全ての通信はこの顧客番号宛に発送される。

顧客番号 7055

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(Supply similar information and signature for third and subsequent joint inventors.)

Japanese Language Utility or Design Patent Application Declaration

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